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A History of the Teaching of Chemistry in the Secondary Schools of the United States Previous to 1850

BY

Samuel Ralph Powers, M.A.

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PREFACE

No less authority than Foster Watson is sponsor for the statement that the history of the study of Latin is the history of secondary education well into the nineteenth century. We have long known in a general way, at least, the factors which delayed the introduction of the natural sciences, but we have been sadly lacking in information as to when and how the natural sciences began their invasion of the curriculum. Mr. Powers has made a valuable contribution not only to the history of the teaching of chemistry, but to the general history of education. He has presented in a clear and interesting manner the many factors which brought chemistry into the foreground of social and intellectual interests and finally secured for it a place in the schools. In addition to the valuable data which his painstaking efforts have brought together, he has made clear the sequence of forces which are universally at work in bringing about changes in school curricula,—namely, new social and industrial needs; quests for new knowledge to meet these needs; rise of a new science (in this case, chemistry); efforts to gain for the new science a place in the schools; establishment of a new study; subsequent formalism and devitalization; efforts to rehumanize or revitalize the now thoroughly established and thoroughly respectable study, by teaching it in close relation to such concrete problems as originally led to its introduction. From this summary statement it is evident that Mr. Powers' study, though treating only one school subject and that for a comparatively brief period, will provide students of the history of education and students of secondary education not only with an explanation of many conditions and factors in the present educational situation, but also with the basis of an illuminating chapter in educational and social philosophy.

FLETCHER HARPER SWIFT,
Professor of Education

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UNIVERSITY OF MINNESOTA

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THE BEGINNINGS OF CHEMISTRY IN THE UNITED STATES

The importance assigned to science subjects in the curricula of American secondary schools[a] prior to the middle of the nineteenth century has not been generally recognized. A writer on the history of education of no less prominence than Cubberley says of the American high-school curricula, "First to be introduced was history and English literature and then the modern languages. In the seventies and eighties came the sciences, first in book form and shortly afterwards as laboratory studies."[1] This same statement is made by Snedden in his article on "The Curriculum" (of the high school) in Monroe's *Principles of Secondary Education*.[2] Such a statement, although carrying with it the support of two eminent educators, is evidently based on a very incomplete knowledge of the facts. Any statement which implies that the sciences were excluded from the curricula of the American secondary schools previous to the middle of the nineteenth century does not correspond with the actual situation. From the facts to be presented in subsequent paragraphs, it will be evident that during the first half of the nineteenth century instruction in elementary science was prominently before the minds of educators; that science had gained a definite place in many secondary schools; that institutions devoted to the training of teachers of science had been established; that the foundation for instruction in science which had been laid during this earlier

[1] E. P. Cubberley, High Schools, Monroe's *Cyclopedia of Education* 3:267b.

[2] Mr. Snedden omits quotation marks and any reference to Cubberley, but evidently he felt that he could rely upon the historical accuracy of Cubberley, as the quotation which constitutes an entire paragraph is verbatim. Paul Monroe, *Principles of Secondary Education* p. 215.

[a] The term secondary school is used in this paper to include all schools offering instruction to pupils of adolescent age. See B. F. Pittenger. Uses of the Term "Secondary" in American Education, *School Review* 24:132.

period was a permanent one; and finally that the present courses in science in our high schools have been built upon these early foundations.

The problem of the present study is to discover when chemistry was first introduced into the secondary schools of the United States; to determine to what extent it became a general study of the secondary schools of the United States prior to 1850; and to discover the factors which have led to its wide introduction into the high schools of to-day. It is believed that the factors which contributed to the introduction and development of chemistry-teaching contributed to the introduction and development of the teaching of the other sciences also, and that they are in part typical of the factors which have led to the introduction of all other subjects which occupy a place in our high-school curriculum.

No complete record of the early history of American schools is available. Journals dealing primarily or incidentally with school matters were published early in the nineteenth century, and it is from such of these as are available that the material for this paper is largely taken. The (first) *American Journal of Education* edited by William Russell began publication in 1826. It was continued as *The American Annals of Education,* edited by W. C. Woodbridge, from 1831 to 1836. These journals are a most important source of information concerning education during the period of their existence. Bulletins and catalogs of courses of study issued by secondary schools, colleges, and universities serve as other important sources of information.[b]

In attempting to establish the time when instruction in chemistry began, it would, of course, be futile to look to a period of time earlier than the science itself. The status of chemical science at the close of the eighteenth century shows that at this time it was too embryonic to have secured a place in any of the secondary schools then in existence. It may be well to note here a few of the more important facts which support this contention.

The eighteenth century witnessed the decline of alchemy and the birth of chemistry. The experimental researches of Black (1728-99), Cavendish (1731-1810), Priestley (1733-1804), and Lavoisier (1743-94) demonstrated to the world the possibilities

[b] For complete list of material consulted see bibliography.

of chemical science. It is said that when, in 1755, Joseph Black graduated from the University of Edinburgh with the degree of M.D., "his thesis on *Magnesia Alba, Quicklime, and Other Alkaline Substances* contained the results of what is probably the first accurately quantitative examination of a chemical action which we possess."[3] The classic researches of Cavendish, Priestley, and Lavoisier on water and the gases of the atmosphere are, indeed, the foundation upon which the modern science of chemistry is built. Notwithstanding the fact that the science of chemistry made considerable progress during the latter part of the eighteenth century, Ernst von Meyer, in his *History of Chemistry,* says that at the beginning of the nineteenth century

> there were practically no laboratories for general instruction in chemistry. In lectures upon physics, mineralogy, and anatomy, chemistry was relegated to a very subordinate place. . . . . It is true that there were chairs of chemistry in various universities and colleges,[c] but the lectures on this subject were usually conjoined with those upon one of the subjects just named, in such a manner that chemistry was forced into the background.
>
> In France, where toward the end of the eighteenth century it began to be perceived that instruction in natural science must be fostered by every means at command, a start was made before any other countries, in respect to the development of chemical study. Up till then apothecaries' shops were the only places where work in practical chemistry could be carried on, and there merely after certain prescriptions and not according to scientific methods.[4]

A statement made in 1790 by Joseph Priestley, the discoverer of oxygen, and a famous pioneer in chemical research, is indicative of the status of scientific subjects in England at this time. Priestley wrote, "I am very sorry to observe that natural science is very little, if at all, the subject of education in this country [England]."[5]

The status of chemical science in American universities at the opening of the nineteenth century is well expressed in an article in the *Medical Repository* for 1800, published at New York, under the caption *Liberal Decree of the Trustees of Columbia College with Respect to Chemistry.*

[3] Pattison M. M. Muir, *Heroes of Science—Chemists* p. 3.

[4] Ernst von Meyer, *History of Chemistry* (tr. by George McGowan) p. 642.

[5] Priestley, *On Air* 1:xxix. Quoted by Florian Cajori, *History of Physics* p. 289.

[c] The first professor of chemistry at Oxford (England) was appointed in 1683. The first professor of chemistry appointed at Cambridge (England) was officially appointed in 1702. Foster Watson, *The Beginnings of the Teaching of Modern Subjects in England* p. 232.

Notwithstanding it has been so long known that natural philosophy, or the science of experimental physics is divided into two great branches, the mechanical and the *chemical,* still the former which only treats of the more obvious and sensible properties of matter, has been taught in colleges and universities. The *latter* which is employed in ascertaining the laws which govern the composition and decomposition of material bodies, and scrutinizing more nearly the relations and affinities of their component atoms, has rarely or never entered the plan of what is termed a genteel or liberal education, but has been improperly considered as auxiliary to the medical profession.[d] The trustees of Columbia College have wisely corrected this error by determining at one of their late meetings that the study of the *chemical branch of physics* should precede the conferring of the degree of Bachelor of Arts upon the students of that seminary; of course the youths educated will have the advantage of becoming acquainted not only with natural philosophy, as it is commonly termed but also with chemistry. This is an example highly worthy of the imitation of other places of instruction.[6]

It appears, however, that there was at least one college that had preceded Columbia[e] in setting this example. John Maclean in his *History of the College of New Jersey* (Princeton) says that this institution made provision for academic instruction in chemistry as early as 1795, and makes the following claim for the priority of New Jersey College:

In the medical schools of Philadelphia, New York, and Cambridge in connection with the University of Pennsylvania and with Columbia and Harvard Colleges, there had been previously to Dr. Maclean's appointment as Professor at Princeton, lectures on Chemistry; but the above mentioned provision for the instruction of undergraduates in this branch of science was the first of the kind ever made in this country, unless possibly, Chemistry in connection with Natural Philosophy and as a branch of it may have been a subject of instruction at the college of William and Mary in Virginia, and the University of Pennsylvania at an earlier date.[7]

[6] *Medical Repository* for 1800, published at New York by Drs. Mitchell and Miller p. 205. Quoted in John Maclean's *History of the College of New Jersey* pp.10-11.

[7] *History of the College of New Jersey* 2:8-9.

[d] The theory of iatro-chemistry developed by Paracelsus (1493-1541) and his followers accounts for the fact that chemistry was taught in the medical schools long before its value as a subject for study in a liberal system of education was recognized.

[e] Columbia had long been giving lectures in chemistry before the medical school. An account of the opening lecture before the medical school is well deserving of mention. "Dr. Smith, Professor of Chemistry gave an introductory lecture on that branch which for elegance and sublimity met with universal approbation." The lecture was given on the day following the opening of the medical school. Quoted from the *New York Mercury* of November 9, 1764, in *A History of Columbia University, 1754 1904* p. 301.

When Williams College at Williamstown, Massachusetts, was organized in 1785, the trustees made provision for the sciences "so far as it may be convenient," but it was not until the election of Professor Chester Dewey in 1812 that the first lectures on chemistry were given.[8]

A list of other colleges and universities which were giving instruction in chemistry during the early part of the nineteenth century together with the date when such instruction began is here given.[f]

TABLE I

BEGINNINGS OF CHEMISTRY AS A COLLEGIATE STUDY IN AMERICA

INSTITUTION	YEAR WHEN CHEMISTRY WAS FIRST INTRODUCED
Columbia College, New York City, N. Y.[9]	1767
University of Pennsylvania, Philadelphia, Pa.[10]	1769
Harvard College, Cambridge, Mass.	1782
College of New Jersey (Princeton), Princeton, N. J.[11]	1795
University of Georgia, Athens	1800
Yale College, New Haven, Conn.	1802
Bowdoin College, Brunswick, Me.[12]	1805
Union College, Schenectady, N. Y.	1811
Brown University, Providence, R. I.[13]	1811
Hamilton College, Clinton, N. Y.	1812
Williams College, Williamstown, Mass.	1812
University of North Carolina, Chapel Hill, N. C.	1818
Western University of Pennsylvania, Pittsburg, Pa.	1819
Amherst College, Amherst, Me.[14]	1822
Dartmouth College, Hanover, N. H.[15]	1823
Trinity College, Hartford, Conn.	1823-24
Hobart College, Geneva, N. Y.	1825
Franklin College, New Athens, Ohio	1825
University of Virginia, Charlottesville, Va.	1825

[8] Calvin Durfee, *History of Williams College* p. 354.

[9] *History of Columbia University, 1754–1904* p. 310.

[10] Frank W. Clarke, A Report on the Teaching of Chemistry and Physics in the United States. Bureau of Education: *Circular of Information No. 6* pp. 200-12. All data in Table I was taken from this report unless other reference is indicated.

[11] *History of the College of New Jersey* 2:8-9.

[12] Nehemiah Cleaveland and Alpheus Spring Packard, *History of Bowdoin College* p. 8.

[13] *Historical Catalog of Brown University* p. 33.

[14] William S. Tyler, *History of Amherst College* p. 30.

[15] John King Lord, *History of Dartmouth College* p. 212.

[f] In some of these institutions the lectures in chemistry were open at first only to the students in the medical department. This list is probably incomplete.

Centre College, Danville, Ky.	1826
St. Louis University, St. Louis, Mo.	1827
Tusculum College, Tusculum, Tenn.	1827
Indiana University, Bloomington, Ind.	1828
Illinois College, Jacksonville, Ill.	1829
Hanover College, Hanover, Ind.	1829
Georgetown College, Georgetown, Ky.	1830
University of Vermont and State Agricultural College, Burlington, Vt.	1830
University of Alabama, University, Ala.	1831
Wesleyan University, Middleton, Conn.	1831
Hiram College, Hiram, Ohio	1831
Randolph Macon College, Ashland, Va.	1832
Wabash College, Crawfordsville, Ind.	1833
Norwich University, Northfield, Vt.	1834
Georgetown College, Georgetown, D. C.	1834
Indiana Asbury University, Greencastle, Ind.	1837
East Tennessee University, Knoxville, Tenn.	1839
Emory and Henry College, Emory, Va.	1839

From the foregoing survey it is clear that but little progress with the study of chemistry was made either in Europe or America previous to 1800; it would be futile therefore to search for chemistry in the American secondary-school curricula that were established previous to the beginning of the nineteenth century.[g]

While chemistry was struggling for recognition as a university subject of study, and even prior to the time when it was given recognition by the universities, its study was being promoted by other agencies. The simple spectacular reactions were sources of amusement for students in all walks of life, and chemistry became a favorite study with the seventeenth-century amateur. Anthony Wood says that in 1663 he and John Locke were members of a private chemistry class at Oxford: "The club wrote and took notes from the mouth of their master who sat at the upper end of the table."[16]

[16] Clark, *Life and Times of Anthony Wood* 1:472. Quoted in Adamson's *John Locke* p. 220 n.

[g] In 1827, of those colleges which offered instruction in chemistry very few if any offered more courses than are now commonly offered in our high schools. In the *Quarterly Journal of the American Educational Society* 1:228-32, is given a View of the Course of Study Pursued in Various Colleges in the United States, from Reports Gathered by the Editor. From the list of 20 colleges reported, only 11 offered instruction in chemistry. In 7 of these chemistry was taught only during the junior year, and in 3 only during the senior year. Only 1 offered as much as two years instruction in this subject.

The seventeenth century witnessed an extraordinary interest in scientific questions. This interest resulted in the establishment of scientific societies in all parts of Europe. Scientific papers were presented before these societies and the transactions of the societies were published. In this way information concerning scientific discoveries was disseminated. How widely and how synchronously the scientific interest spread over Europe during the seventeenth and early eighteenth centuries is shown by the following table.[17]

TABLE II

EARLY SCIENTIFIC SOCIETIES[18]

SOCIETY	PLACE ESTABLISHED	DATE
Royal Society	London	(about) 1650
Accademia del Cimento	Florence	1657
Academia Naturae Curiosorum	Vienna	1652
Académie Royale	Paris	1666
The Berlin Academy	Berlin	1700
The St. Petersburg Academy	St. Petersburg	1725
The Stockholm Academy	Stockholm	1739
The Copenhagen Academy	Copenhagen	1743

An attempt has been made in the preceding pages to show something of the status of science in Europe and America in 1800. Immediately following 1800, interest in scientific study in America experienced a rapid growth. This fact makes the early decades of this century of especial interest in this paper. The evidences of this growth of interest in scientific study together with the causes which led to it will next be considered. The status of science in America during the eighteenth and early nineteenth centuries is well expressed in an unsigned article in the *American Monthly Magazine* for 1817 entitled, "Survey of the Progress and Actual State of Natural Science in the United States of America from the Beginning of the Century to the Present Time."[19] This article is of such value not only in showing something of the status of science in America in 1800, but also in giving an account of the rapid development of science between 1800

[17] The data included in this table is taken from Ernst von Meyer's *History of Chemistry* p. 108.

[18] *Ibid.*

[19] Unsigned article. Survey of the Progress and Actual State of Natural Sciences in the United States from the Beginning of the Century to the Present Time. *American Monthly Magazine* 2:81-89.

and 1817, that it deserves a rather extended summary.[h] The author begins by stating that the American contributions to science during the eighteenth century were slight compared with those of European countries. However, he names several Americans who had devoted some attention to the study of science. Among these were Winthrop, Franklin, Jefferson, and Priestley.[20]

The lack of interest in scientific study in America during the eighteenth century is evident from the fact that previous to 1800 no learned societies had been established which assumed the study of science as the basis of their labors. Certain societies established during this century did, however, include natural science within their range. The most important of these were:[21]

	FOUNDED
The Philosophical Society of Philadelphia	1744
The American Academy of Arts and Sciences, Boston	1780
The Connecticut Academy of Arts and Sciences, New Haven	1799

The first two decades of the nineteenth century witnessed a rapid growth in interest in science, and during this period scientific societies were established in many American cities. Among those established between 1800 and 1817 were:[22]

	FOUNDED
The Linnean Society of Philadelphia	1804
The Columbian Chemical Society of Philadelphia	1811
The Literary and Philosophical Society of New York	1814
The Literary and Philosophical Society of Charleston	1814
The Academy of Natural Sciences of Philadelphia	1815
The Cabinet of Sciences of Philadelphia	1815
The Lyceum of Natural History of New York	1817

These societies were interested chiefly in natural history, mineralogy, and geology. They founded museums of natural history and botanical gardens, and made mineral collections. Under their influence horticultural pursuits became so popular that they were considered fashionable.[23]

Evidence of rapid growth of interest in science following 1800 is gained when we learn that, of the more than forty colleges in

[20] Unsigned article. Survey of the Progress and Actual State of Natural Sciences in the United States from the Beginning of the Century to the Present Time. *American Monthly Magazine* 2:82.

[21] *Ibid.*

[22] *Ibid.*

[23] *Ibid.* p. 83.

[h] The summary which begins at this point continues through page 129. It will of course, be understood that the data cited are all from this article.

existence in 1817, all taught natural philosophy, some taught chemistry, and a few taught natural history.[24] In the universities all these branches had professors in 1817. How inadequate and superficial much of this work in the universities was is evident from the statement that professors were sometimes appointed "who have yet to learn what they are to teach."[25]

Men from all walks of life were interested in scientific study. The pursuit of scientific study was, in fact, a popular pastime for the leisure hours of men in many different professions. Physicians most prominently devoted themselves to science and did most of the teaching. Next to the physicians the clergy contained the greatest number of scientists. But there were also scientists of some note among the merchants, gentlemen of the navy, lawyers, and wealthy citizens. Among those of greatest prominence in the field of chemistry were Doctors MacNeven, Priestley, Dexter, Silliman, Mitchell, Coxe, Cutbush, Seybert, Gorham, and Messrs. Cooper, Hare, and Griscom.[26]

These men of science made many discoveries. It is stated that American

> chemists and mineralogists discovered many substances hitherto [1817] not detected in North America and even some new substances; they verified the European discoveries and in a few instances anticipated them in some measure; mineral waters, metallic substances, and fossil bodies were analyzed; some improvement in nomenclature, apparatus, and experiments were introduced; and experimental chemistry was eagerly taught to all classes of society.[27]

The rapid growth of interest in science in America was soon recognized by Europe. William McClure, Esq.,[1] wrote in a letter to the editor of *The American Journal of Science,* dated at Madrid, December 4, 1821:

> I am glad to hear of the rapid progress science in general, (and mineralogy and geology in particular) makes in the United States. The men

[24] Unsigned article. Survey of the Progress and Actual State of Natural Sciences in the United States from the Beginning of the Century to the Present Time. *American Monthly Magazine.* 2:82.

[25] *Ibid.* p. 84.

[26] *Ibid.* pp. 86-89.

[27] *Ibid.*

[1] William McClure (1763-1840) was the first American disciple of Pestalozzi. He retired from business in 1803, and in 1806 wrote the first article published in America on Pestalozzianism. He studied in Europe with Pestalozzi and Fellexberg. In 1824 he joined Robert Dale Owen at New Harmony, Indiana, and invested $150,000 in Owen's utopian colony there. Mr. McClure was active in many scientific societies and a prolific writer. W. S. Monroe, McClure, William, *Cyclopedia of Education* 4:104.

of Science in Europe are astonished at the rapidity with which one discovery succeeds another and cannot conceive, how, in so short a time, so many hands and heads are occupied with the exact sciences and mechanics.[28]

In 1826 it is called to our attention by Isaac Lea that

the study of natural history has within the last thirty years engaged much more general attention than at any previous period.[29]

And again we read that,

So rapid has been the progress of chemical science during the last ten or fifteen years, [1826] that our older scholars frequently complain, that it has passed almost out of their field of view.[30]

Paralleling and stimulating the growth in scientific interest in chemical phenomena there developed increasing recognition of possible applications of chemistry to manufacturing pursuits and to agriculture. In spite of the fact that not much progress was made in applying chemistry to industry and agriculture, the possibility of such applications was continually referred to in the literature, even from the beginning of the nineteenth century. This recognition, together with the incessant demand for the practical in education, must have been a considerable factor in influencing the schools to include chemistry and other natural-science subjects in their curricula. The possibility of extensive application of chemistry to industry was expressed in 1815. It was said that chemistry was

an important aid to the study of mineralogy, pharmacy, electricity, cooking, metallurgy, and in various manufacturing industries, especially glass, leather, soap, paint, glue, starch, etc. . . . . In fact it would be an easy task to continue almost indefinitely the list of arts whose processes, if they admit of explanation at all, must be explained upon the principles of chemical philosophy.[31]

As early as 1811 organized effort had been made to promote scientific agriculture. *The Memoirs of the Philadelphia Society for Promoting Agriculture* for 1811 recognized the possible application of chemistry to the maintenance of soil fertility. It included articles on the use of lime, gypsum, leached ashes, and salt

[28] Extract of a letter from William McClure, *American Journal of Science* 5:197.

[29] Isaac Lea, On the Pleasures and Advantages of Studying Natural History, *American Journal of Science* 11:218.

[30] Denison Olmstead, On the Present State of Chemical Science, *American Journal of Science* 11:349.

[31] An essay of the Classification, Mutual Relations, and Various Uses of the Physical Sciences. (Unsigned.) *Analectic Magazine* 6:145.

as materials for fertilization, and lamented the lack of more exact knowledge on the use of these substances.[32] Early students of scientific agriculture looked to chemistry to supply this exact knowledge, but apparently little progress was made with agricultural chemistry during the first half of the century. In 1841 it was said that

> although the science of Agriculture had a vigorous commencement in the labors of Davy and Chaptal, yet its subsequent progress had not been correspondingly rapid and it must yet be regarded as in its infancy.[33]

As regards industrial chemistry, the records show that there were some applications of chemistry made to industry at a very early date, but manufacturing based upon applications of chemistry has only recently become an important phase of industry in the United States.[j] As late as 1870, when the value of manufactured chemical products in France was $250,000,000, the total value of American chemical products, including fertilizers, was but $25,217,000.[34]

[32] *Memoirs of the Philadelphia Society for Promoting Agriculture,* containing communications on various subjects in husbandry and rural affairs. 2. 1811. An extensive review of these memoirs is given in the *American Review* 2:78-101.

[33] Edward Hitchcock, First Anniversary Address before the Association of American Geologists at the Second Annual Meeting in Philadelphia, April 5, 1841. *American Journal of Science* 41:262.

[34] Albert S. Bolles, *Industrial History of the United States* p. 489.

[j] Dr. John Pennington in *Chemical and Economical Essays, 1790,* described a process for the manufacture of Prussian blue. Recorded in *Mease's Archives* 3:129 and cited by J. L. Bishop, *A History of Manufactures in the United States* 2:262 n. John Harrison was fully established in the manufacture of oil of vitriol in 1806, and in 1807 produced 425,000 pounds. S. Wetherill and Sons, Farr and Kunzi (later known as Powers and Weightman), and the House of Kalbfleisch and Sons were three prominent American chemical manufacturing establishments which began operations between 1820 and 1830. For a detailed account of the early history of chemical industry in the United States, see *A History of Manufactures in the United States* 3:73-77.

CHAPTER II

BEGINNINGS OF CHEMISTRY IN AMERICAN SECONDARY SCHOOLS—THE ACADEMY

Before we can enter intelligently upon the discussion of the beginnings of chemistry in American secondary schools, we must give some account of that type of secondary school, the academy, which was the first to give science and particularly chemistry a place in its curriculum.

A study of the educational situation in the United States in the early part of the nineteenth century shows that there were several types of schools making bids for places in the educational system. The earliest of these was the Latin-grammar school. The first Latin-grammar school was founded in Boston in 1635.[1] The next dominant type was the academy. Finally the high school came into existence. During the later part of the eighteenth, and the earlier part of the nineteenth, centuries, agricultural, industrial, and scientific schools were founded in many places in the United States. As early as 1780 the state of Massachusetts had aimed to encourage, by rewards and immunities, private societies and public institutions to provide schools for the promotion of agriculture, arts, sciences, commerce, trades, and manufacturing.[2]

The earliest type of American secondary schools, the Latin-grammar school, gave no place to the teaching of chemistry, nor indeed to that of any other natural science. The reason for this is to be found in the fact that its curriculum was consciously modeled after that of the European Renaissance classical schools. The aim of these Renaissance classical schools was to produce boys capable of speaking, reading, and writing classical Latin correctly and fluently. The realization of such an aim left little time for anything else, and made their curriculum impervious to the influence of the great scientific movement going on about them. The curriculum of the Latin-grammar school was distinctly designed to meet the needs of the professional and aristocratic

[1] Second report of the Record Commissioners of the city of Boston, pp. 4-5, quoted by E. E. Brown, *The Making of Our Middle Schools* p. 35 n. 1.

[2] Palmer C. Ricketts, *History of Rensselaer Polytechnic Institute* p. 4.

classes. It offered no satisfactory education for the great mass of American youths who were not preparing for college. American statesmen were among the first to deplore this deficiency in education, and very early began to make demands for a more liberal and extensive system.

One of the first to point out the need for instruction of all the people in the practical applications of the sciences was Benjamin Franklin. In like manner Thomas Jefferson, in his plan for a state university written about 1816, proposed a school of technical philosophy, to be maintained wholly at public expense, where certain of the higher branches should be taught in abridged form to meet certain practical needs. To such a school, he wrote,

> will come the mariner, carpenter, shipwright, pumpmaker, clock-maker, machinist, optician, metallurgist, founder, cutler, druggist, brewer, vintner, distiller, dyer, painter, salt-maker, glass-maker, to learn, as much as shall be necessary to pursue their arts understandingly, of the science of geometry, mechanics, statics, hydrostatics, hydraulics, hydrodynamics, navigation, astronomy, geography, optics, pneumatics, acoustics, physics, chemistry, natural history, botany, mineralogy, and pharmacy.[3]

It was to meet this demand for a type of education suited to the need of a larger public than that served by the Latin-grammar school that the American academy arose. It was in 1749 that Benjamin Franklin made public his proposal to establish an academy which would provide instruction in "those things that are likely to be most useful and most ornamental." The academy movement spread quite rapidly over the United States following the War of Independence. Winterbotham's *View of the American United States,*[4] written in 1795, gives some facts concerning the state of secondary education at that time. He makes special mention of certain academies in each of the original thirteen states. The statements concerning academies in Virginia indicate clearly that there were others in existence than those mentioned. He said: "There are several academies in Virginia; one at Alexandria, one at Norfolk, and others in other places." From his statements the material in the following table was compiled. This

[3] *Early History of the University of Virginia as Contained in the Letters of Thomas Jefferson and J. C. Cabell.* Edited by J. W. Randolph, Richmond, 1856. Quoted in *The History of Rensselaer Polytechnic Institute* p. 5.

[4] W. Winterbotham, *An Historical, Geographical, Commercial, and Philosophical View of the American United States, and of the European Settlements in America and the West Indies.* The material given here is compiled from quotations from this work given by *The Making of Our Middle Schools* pp. 199-202.

table is by no means exhaustive, since it gives merely the number of academies specially mentioned in Winterbotham's account.[5]

New Hampshire	6	Maryland	1
Massachusetts	6	Virginia	3
Maine	4	North Carolina	5
Rhode Island	1	South Carolina	4
Connecticut	5	Georgia (Provision had been made for an academy in each county)	
New York	8		
Pennsylvania	6		

The Regents of New York University reported in 1827 that there were 45 incorporated academies in New York State giving instruction to 3,050 students.[6] And by 1840 there had been established in North Carolina as many as 118 academies.[7] In a "partial list" of the academies of West Virginia published by Thomas A. Miller, state superintendent, are given the names of 17 academies founded earlier than 1830, and 45 founded earlier than 1850.[8] It was in the academy that chemistry first secured a place as a secondary school subject.

That it was the aim of the academies to furnish a practical education is shown by the very extensive list of subjects in their curricula. Something of the character of the students resorting to the academy and the extensiveness of the curriculum may be gleaned from a statement contained in a lecture delivered by William C. Fowler[a] in 1831. He said, students

> repair to the academy or high school for one or two quarters and sometimes longer, to complete their education. . . . . [They] comprise those who have become acquainted with the common branches of school education; and who go to the higher institutions to add a knowledge of some of the higher branches, to polish off their learning and prepare themselves to be teachers, or for some of the professions of active life. Having much to learn, and but little time, besides reviewing English grammar, arithmetic, and geography, they wish to study natural philosophy, rhetoric, composition, logic, astronomy, perhaps surveying, and by all means chemistry, and may be several other branches . . . .[9]

[5] *An Historical, Geographical, Commercial, and Philosophical View of the American United States, and of the European Settlements in America and the West Indies.* The material given here is compiled from quotations from this work given in *The Making of Our Middle Schools* pp. 199-202.

[6] Extract from The Report of the Regents of New York University for 1827. *American Journal of Education* 3:357.

[7] Charles L. Coon, *Publications of the North Carolina Historical Commission. North Carolina Schools and Academies 1790–1840. A Documentary History.* The 118 academies were listed in the index.

[8] Thomas A. Miller, *History of Education in West Virginia* pp. 37-38.

[9] William C. Fowler, *Influence of Academies and High Schools on Common Schools. Introductory Discourses and the Lectures Delivered before the American Institute of Instruction, in Boston, August, 1831* pp. 193-94.

[a] William C. Fowler was a professor in Middlebury College, Middlebury, Vermont.

As might be expected, the development of the academy movement carried with it marked hostility to the traditional secondary-school curriculum. Some supporters of the academy movement appear almost fanatical in their opposition. In 1803, Representative O'Farrell introduced into the legislature of the state of North Carolina a "Bill To Establish Academies in Each County." The bill (which failed to pass) provided that

> the course of education to be established in said academies shall consist of the study of the English Language, writing, arithmetic, mercantile book-keeping, geometry, trigonometry, mensuration or surveying, navigation, geography, natural and experimental philosophy, and the laws of North Carolina.

The bill provided further

> that the study of the dead languages as being useless in a republican form of government and a great waste of time shall form no part of the course of education of the sciences.[10]

Representative O'Farrell's conception of the purpose of the academies in the American educational system was no doubt in substance the same as that of many of the educators of the time. The general conception was that the purpose of the academy was to prepare the American youths to fulfil their responsibilities as democratic citizens. It was felt that there should be provided not only instruction which would prepare students for college, but also instruction which would fit the larger group of students, not preparing for college, to gain their livelihood by work in the trades and industries. In addition to these two aims some of the academies attempted to realize a third, namely, to provide courses of study similar to those offered by the colleges and universities. The importance of the academy as a connecting link between the common school and college is well shown by such statements as the following taken from a lecture already quoted by William C. Fowler. He said:

> The Academies have a direct influence on the college, inasmuch as they furnish them with a large part of their students; and upon the common schools since they supply them with a considerable number of teachers. And it is through them that the lads must pass in their ascent to the colleges.[11]

[10] *Unpublished Legislative Documents, 1803.* Charles L. Coon, *Publications of the North Carolina Historical Commission; Public Education in North Carolina. A Documentary History* p. 46.

[11] *Influence of Academies and High Schools on Common Schools. Introductory Discourses and the Lectures Delivered before the American Institute of Instruction in Boston, 1831* pp. 183-87.

The primary importance of the academy from the standpoint of this paper is that it was the academy which first fostered the teaching of chemistry to adolescents. Something of the extent to which chemistry was included in the curriculum of the academy is shown in Table III.[b]

TABLE III

ACADEMIES AND OTHER SECONDARY SCHOOLS TEACHING CHEMISTRY

INSTITUTIONS	CHEMISTRY TAUGHT AS EARLY AS
North Carolina[12]	
Hassam Private Academy	1819
Greensboro Academy	1821
Andrews and Jones North Carolina Female Academy, Oxford	1822
Forest Hill Academy near Raleigh	1823
Raleigh Academy	1823
Hillsborough Female Academy	1825
Charlotte Female Academy, Catawba	1826
La Vallee Female Academy, Halifax	1826
Tarborough Academy	1826
Bingham's Military School, Oxford	1830
Berkeley's Literary and Scientific Institute for Young Ladies	1831
Kerr's Male and Female School, Raleigh	1831
Bowen's School, Raleigh	1831
Mulock's English School, Wilmington	1837
Vine Hill Academy	1837
Grove Academy, Wilmington	1840

[12] *Publications of the North Carolina Historical Commission. North Carolina Schools and Academies 1790–1840. A Documentary History.* See index for references to each of the North Carolina institutions here listed.

[b] It has been possible to gather some information concerning the subjects taught in certain of the early American academies. The North Carolina Historical Commission has made a very exhaustive study of the North Carolina schools and academies from 1790 to 1840. Their report of this study includes many reproductions of original advertising material, reproductions of courses of study, daily programs, and other material. The accessibility of this material accounts for the relatively large place given to the schools of North Carolina. The condition of education in North Carolina may or may not be typical of conditions in other states. Other information concerning the subjects taught in the early academies was gathered from the files of early American educational journals, and from a report of a questionnaire survey conducted by F. W. Clarke under the direction of the United States Bureau of Education. Mr. Clarke's questionnaire was sent to schools all over the United States. The schools were asked, among other things, to state in what year the institution began giving instruction in chemistry. In Table III (pp. 16-17) has been listed by states a number of academies which were known to have provided instruction in chemistry at an early date. Much of the information in this table has been taken from school announcements for a particular year. The fact that chemistry was included in the course of study for a given year is evidence only that chemistry was taught as early as that year, but gives no clue to how much earlier it may have been taught. The lists for New York, Massachusetts, and Connecticut are probably far from complete. The difficulties in the way of securing such information as that given here prohibited the further extension of this list.

Massachusetts	
Wesleyan Academy, Wilbraham[13]	1826
Chauncy Hall School, Boston[14]	1828
Phillips Academy at Andover[14]	1830
Ipswich Female Seminary[15]	1833
West Newton English and Classical School[14]	1848
Connecticut	
Emerson Female Seminary, Wethersfield[18]	1826
New Haven Gymnasium[16]	1827
Greenwich Academy	1829
Hartford Female Seminary[17]	1832
New York	
Onondaga Academy[14]	1813
Clinton Grammar School[14]	1815
Hartwick Seminary[14]	1815
Albany Academy[19]	1822
Troy Female Academy[19]	1822
Gouverneur Wesleyan Academy[14]	1830
Delaware Academy, Delhi[14]	1830
Rochester Female Academy[14]	1837
Gilbertsville Academy and Collegiate Institute[14]	1840
Red Creek Union Seminary[14]	1840

In the table here given there are 4 academies which gave instruction in chemistry previous to 1820, 15 that began such instruction not later than the period of 1820-29, and 14 that began not later than the period between 1830-40.

The Onondaga Academy (New York), which gave instruction in chemistry to its students as early as 1813, is probably one of the first academies in the United States to provide such instruction.[c] Some light upon the importance of chemistry in the

[13] *American Annals of Education* 1:187.

[14] A Report on the Teaching of Chemistry and Physics in the United States. Bureau of Education: *Circular of Information, No. 6,* pp. 176-92.

[15] *American Annals of Education* 3:76.

[16] S. E. Dwight and H. E. Dwight, Prospectus of the New Haven Gymnasium. *American Journal of Science* 13:385-86.

[17] *American Annals of Education* 2:65.

[18] *American Journal of Education* 1:506.

[19] Amos Eaton, *Chemical Instructor: Presenting a Familiar Method of Teaching the Chemical Principles and Operations of the Most Practical Utility to Farmers, Mechanics, Housekeepers, and Physicians; and Most Interesting to Clergymen and Lawyers. Intended for Academies and for the Popular Class-Room* p. 3 n. This work is referred to hereafter as the *Chemical Instructor.*

[c] John Griscom taught chemistry to his more advanced students in the common school over which he had charge at Burlington, New York, as early as 1806. An account of Griscom's work is given below. See page 24 ff.

course of study, as well as upon the methods used in teaching it, may be gleaned from the following statements made in the announcements from which the data in the above Table III are taken.[d]

An advertisement in the *Raleigh* (North Carolina) *Register* under date of March 23, 1827, setting forth the claims of the Oxford Female Academy reads:

> Since the commencement of the session we have received a Chemical and a Philosophical Apparatus and now each recitation in Chemistry, Philosophy, and Astronomy, is accompanied with a Lecture and Experiments illustrating the principles of these sciences.[20]

From an advertisement setting forth the claims of the Warrenton Female Academy, we learn that

> an extensive apparatus for Natural Philosophy and Chemistry were constantly used in teaching those branches which require their aid, affording facilities not possessed by any other Female Seminary in the United States.[21]

According to the announcement of the Wesleyan Academy at Wilbraham, Massachusetts, that institution gave lectures and experiments on chemistry as applied to the useful arts.[22] Continuing our study of these school announcements we learn that the Mount Hope Literary and Scientific Institution at Baltimore, Maryland, which admitted pupils of from four to sixteen years of age gave instruction in chemistry as applied to the arts, agriculture, and mineralogy;[23] that in the New Haven Gymnasium, a school for the education of boys,

> students not intending for college who have been sufficiently long in the course of education and have made the requisite attainments will be permitted to attend the course of lectures on chemistry, mineralogy and geology given by Professor Benjamin Silliman;[24]

and also that the Adams Female Academy at Derry, New Hampshire, was furnished with a good chemical laboratory.[25]

[20] *Raleigh Register,* March 23, 1827. Quoted in *Publications of the North Carolina Historical Commission. North Carolina Schools and Academies 1790–1840. A Documentary History* pp. 156-57.

[21] The (Warrenton) *Star,* December 8, 1820. Quoted in *Publications of the North Carolina Historical Commission. North Carolina Schools and Academies 1790-1840. A Documentary History* p. 447.

[22] *American Journal of Education* 1:187.

[23] *Ibid.* 3:620.

[24] Prospectus of the New Haven Gymnasium; a School for the Education of Boys, *American Journal of Science* 13:385.

[25] *American Annals of Education* 2:147.

[d] School advertisements are probably unreliable. For this reason the importance of the following quotations should probably be discounted.

In the preparation of this study much effort has been made to gather material like that just given, but for no state except North Carolina is material available which makes possible anything approaching an exhaustive study. There is certainly no reason to believe that the academies of North Carolina gave more attention to teaching chemistry than the academies of the other states, but rather that the conditions there were typical of what would be found in the other states if studies comparable to those of the North Carolina Historical Commission were made.

Further evidence that chemistry was taught in the academies as widely as the available statistics indicate is gained from the preface of Amos Eaton's[e] *Chemical Instructor,* written in 1822, in which he apologizes for having prepared another textbook for use in the academies when there were already so many books of this kind available.[26] And in an analysis of the course of study given by Chester Dewey, Principal of the Pittsfield, Massachusetts, Gymnasium, before the meeting of the American Lyceum, in 1833, he stated that the least instruction intended to be given in any of the common schools is reading, spelling, and writing. In the next higher grade of school, there is given a partial knowledge of English grammar, and of the elementary rules of arithmetic, with a very little geography. In the next grade all these branches are studied to much greater perfection and extent, and perhaps some history is read. In the highest of the common schools, and in some select schools, are taught rhetoric, some philosophy and chemistry, arithmetic fully, and some Latin and Greek. The academies and higher grammar and select schools pursue all these studies.[27]

From the same sources which have furnished us with evidence as to the extent to which chemistry was taught, we may also gain information concerning the methods used. The method advocated by those most prominent in the work of teaching chemistry was

[26] *Chemical Instructor* p. 2.

[27] Chester Dewey, Natural Science in Common Schools. *American Annals of Education* 5:304.

[e] Amos Eaton was senior professor at Rensselaer from 1824 to 1842. (W. S. Monroe's statement that he was president of Rensselaer, made in a biographical sketch of Amos Eaton in the *Cyclopedia of Education,* is in error.) During his stay at Rensselaer he devoted much attention to the training of science teachers. The prominence which he achieved as a teacher shortly after the publication of the *Chemical Instructor* makes the many ideas expressed here concerning equipment, content, and method for the work of teaching chemistry especially significant. See below, p. 47 ff.

that of giving lectures accompanied by experimental demonstrations. One school announcement states that each recitation in chemistry is accompanied by a lecture and experiments illustrating the principles.[28] Another states that

> an extensive apparatus for Natural Philosophy and Chemistry were constantly used in teaching those branches.[29]

Another, according to its announcement, gave lectures and experiments on chemistry.[30] In another

> a neat and well selected apparatus together with a handsome cabinet of minerals facilitated the task of instruction in the several studies of Chemistry, Natural Philosophy, and Mineralogy.[31]

Again,

> the Lectures on Chemistry were illustrated by the best apparatus the incipient state of the institution will afford.[32]

It is difficult to determine just how much use was made of the laboratory by the pupils, but probably not very much. Amos Eaton advocated that the pupils be required to handle the apparatus in order that they might better understand the experiments afterwards to be performed by the instructor.[33] Laboratory equipment was difficult to procure. Amos Eaton, in his book just referred to, gave directions for making or borrowing from a druggist most of the apparatus required for the experiments outlined in his text. Larger pieces of apparatus when desired were ordered from England. The problem of equipment was certainly one which contributed in no small degree to the difficulties which stood in the way of efficient instruction.

The existence of elementary textbooks was unquestionably essential to the promotion of instruction in chemistry in the academies. This was especially true since there was, during this period of pioneering, a shortage of qualified chemistry teachers.

[28] *Raleigh Register,* March 23, 1827. Quoted in *Publications of the North Carolina Historical Commission. North Carolina Schools and Academies 1790-1840. A Documentary History* pp. 156-57.

[29] The (Warrenton) *Star,* December 8, 1820. Quoted in *Publications of the North Carolina Historical Commission. North Carolina Schools and Academies 1790-1840. A Documentary History* p. 447.

[30] *American Journal of Education* 1:187.

[31] *Raleigh Register,* December 16, 1830. Quoted in *Publications of the North Carolina Historical Commission. North Carolina Schools and Academies 1790–1840. A Documentary History* p. 305.

[32] *Ibid.* p. 564.

[33] *Chemical Instructor* p. 9.

It is probably more than a coincidence that three of the elementary textbooks listed below were written in 1822. In Table III are listed eleven academies which began giving instruction in chemistry not later than the period between 1822 and 1826. These two facts point to the conclusion that the decade of 1820 to 1830 witnessed a rapid growth in the extension of chemistry as a secondary-school subject.

An attempt to determine the number of textbooks in use during a given period is just as impossible as to determine how many schools included chemistry in their curricula. There are listed below eight elementary texts in chemistry which appeared between 1822 and 1833. In addition to these there were twenty or more other chemistries which had been written for use in the colleges. It is highly probable that a considerable number of these college texts were also used in the academies.

Monroe, discussing the use of textbooks in science in the United States, says that "by 1832 there were 39 geographies, 11 astronomies, 6 botanies, 5 chemistries, and 6 natural philosophies. Most of these were designed for use in the academies."[34] It is difficult to understand why Monroe would make such a definite statement as this when it is clearly impossible to state the exact number of books that were in use during this period.[f] We can say that there were at least as many in use as we can find record of, but we can have no assurance that we have record of all. Again, the error in this statement is evident, for we have listed below the names of 8 books written or revised in America and in use in American secondary schools, 7 of which appeared previous to 1832.

The list of books here given includes only those which were written specifically for use in the secondary schools.

The Chemical Instructor,[35] written in 1822 by Amos Eaton, was "intended for academies and the popular classroom."[g] This book in comparison with those used in the colleges was quite brief and elementary.

[34] Paul Monroe, *A Brief Course in the History of Education* p. 365.
[35] *Chemical Instructor* p. 3.

[f] This statement of Professor Monroe typifies the lack of accurate information concerning this period of American education.
[g] A copy is in the library of the University of Minnesota.

An Introduction to Chemistry, with practical questions, designed by John R. Cotting for beginners in the science, was written in 1822.[36]

A Grammar of Chemistry,[h] "adapted to the use of schools and private students, by familiar illustrations and easy experiments," was written in 1822 by Dr. J. L. Comstock.[37]

The Juvenile Philosopher; or Youth's Manual of Philosophy in Four Parts; I, Natural Philosophy; II, Astronomy; III, Chemistry; IV, Physiology, was written in 1826, for the use of schools and juvenile readers.[38]

The Elements of Chemistry for the use of schools and academies (1827) by Fyfe of Edinburgh; with additions and alterations by John W. Webster of Harvard University, was especially recommended for use in the academies by the editor of *The American Journal of Education.*[39]

Conversations on Chemistry, in which the elements of that science are familiarly explained by Mrs. Bryant, was edited in America by J. L. Comstock, 1830.[i]

New Conversations on Chemistry, by T. P. Jones, was written in 1831.[40]

Elements of Chemistry, with practical exercises for use of schools, by Francis J. Grund, was written in 1833.[41]

In addition to these eight, nineteen other texts on chemistry were listed in the advertising pages of *Robert Hare's Compendium of the Course of Chemical Instruction in the Medical Department of the University of Pennsylvania,* published by Joseph G. Auner, Philadelphia, 1836.[j] This makes a total of twenty-seven chemistry texts which were offered for sale in the United States as early as 1836. The fact that the eight books listed above, and probably others, were prepared primarily for use in the academies

[36] Book review. *American Journal of Science* 5:404.

[37] *Ibid.*

[38] Book review. *American Journal of Education* 1:636.

[39] *Ibid.* 3:228-31.

[40] Book review. *American Annals of Education* 1:400.

[41] Book review. *American Journal of Science* 25:426. Revised also in *American Annals of Education* 3:600.

[h] A second edition of this book was published in 1825. A copy is in the library of the University of Minnesota. It is reviewed in the *American Journal of Education* 1:316.

[i] A copy was available to the writer. This 1830 publication was a "twelfth edition."

[j] A copy is in the library of the University of Minnesota.

proves quite conclusively that chemistry occupied a place of considerable prominence in the curriculum of the academy of this period, for certainly these books would not have been prepared had there not been a demand for them.

It would of course be erroneous to conclude that the teaching of chemistry in the early academies was done efficiently. The lack of equipment and, worse still, the dearth of trained teachers made efficient instruction impossible. In 1830, Catherine Beecher,[k] (1800-78), reported to the Trustees of the Hartford Female Academy that in the schools below the colleges

> one teacher has been considered sufficient to teach Reading, Spelling, Grammar, Geography, Arithmetic, Composition, History, Natural Philosophy, Chemistry and the list in many cases might be extended to some eighteen or twenty other branches. In addition *one room* has been considered sufficient for every recitation, and every school exercise, as well as for the place devoted to study. As for apparatus for explanation and illustration it has been entirely out of the question; and had it been furnished, it would have been of little avail to teachers debarred from their duty and privilege of communicating knowledge, and condemned to spend their whole time in endeavoring to discover how much pupils have learned from books without the aid of a teacher.[42]

Even at as late a date as 1854 Francis Wayland[l] said before the American Institute of Instruction:

> I have no doubt that thousands of the pupils of the somewhat advanced schools have gone through a system of chemistry supposing that they have studied that science without ever having witnessed a single experimental illustration, and whose whole knowledge consisted in the recollection for a few weeks of some of the terms of the chemical nomenclature.[43]

These statements indicate quite clearly that the textbook and question and answer method was by necessity widely predominant.

[42] Catherine E. Beecher, Principal. *Suggestions Respecting Improvement in Education, Presented to the Trustees of the Hartford Female Academy and Published at Their Request.* Extracts from, printed in the *American Journal of Education* 5:63-66.

[43] Francis Wayland, *A Review of the Progress of Education in This Country during the Past Twenty-five Years. Lectures Delivered before the American Institute of Instruction at Providence, 1854* p. 8.

[k] Catherine Beecher was quite a prominent educator and a strong advocate of household science courses for girls. For a sketch of her life see Barnard's *American Journal of Education* 28:65-96.

[l] Francis Wayland was the first president of the American Institute of Instruction, organized in 1830, at which time he was president of Brown University.

CHAPTER III

EFFORTS TO POPULARIZE CHEMISTRY AS A SUBJECT FOR SECONDARY EDUCATION

The previous chapter endeavored to show the place and importance of chemistry as a subject in the American secondary school in the first third of the nineteenth century. It has been noted that, although many of the academies included chemistry in their course of study, the instructors in chemistry were often ill prepared and consequently necessarily inefficient. Before science could hope to occupy a place of genuine prominence in the secondary-school curriculum several things were necessary. It was necessary that the public be made to recognize the need for instruction in science, that competent teachers be provided, and that satisfactory textbooks and apparatus be made available.

Efforts along all these lines appeared early in the nineteenth century. About 1820, steps were taken (1) to create a public sentiment which would be favorable toward giving scientific instruction a place in secondary schools; (2) to provide science teachers; and (3) to make apparatus available for use in the schools. The effort to supply these needs was led by certain individuals, chief of whom were John Griscom, Josiah Holbrook, Chester Dewey, Stephen Van Rensselaer, and Amos Eaton. These pioneers gave popular lectures on scientific subjects; they fostered the formation of popular scientific societies and teachers' associations, particularly the American Lyceum and the American Institute of Instruction; they studied the European scientific schools, particularly Fellenberg's institution at Howffyl, Switzerland; they endowed and encouraged the endowment of scientific schools in America, particularly the Rensselaer School at Troy, New York. Of these pioneers John Griscom (1774-1852) was one of the first to take a prominent part in the movement to popularize chemistry. Mr. Griscom, teacher of a Friends school at Burlington, New York, and a man of much ability, spent his leisure hours studying scientific subjects. He was much interested in natural philosophy, and in order to extend his interest purchased from England, with the profits from his school, an air pump and other

articles of apparatus from which he derived much pleasure. He heard of chemistry and was at once desirous to learn something of the subject which promised to unlock so many wonderful secrets. He secured a copy of Dr. Henry's *Epitome of Chemistry,* but after much effort was forced to conclude that chemistry was too difficult a subject of study to be understood by any means other than by professional study with the aid of an instructor. Later a friend loaned him a copy of an English translation of Lavoisier's chemistry. With this book he had greater success. He said that he read it with "utmost delight, understood everything clearly, and found it the most interesting study he had ever engaged in."[1] He next procured some chemical apparatus, and together with one of his more advanced pupils worked out some of the experiments described by Lavoisier. From this time forward he labored to enlarge his laboratory, sought the acquaintance of chemists, and read other chemistry texts. A later edition of Dr. Henry's *Epitome* he described as "perfectly intelligible and delightful." By 1805 he had performed successfully every experiment within the reach of his apparatus, and during the same year he gave instruction to his more advanced pupils in the common school of which he had charge. He remarked that his efforts were probably the first made in that part of the United States to teach chemistry in the common schools.[2] During the autumn of 1806 he issued a handbill proposing to the citizens of Burlington a course of public lectures on chemistry, to be given at his schoolroom. The proposition, he said, was well received and the most intelligent citizens gave it their patronage.

Mr. Griscom's success in his schoolroom as a teacher, and also his success in his new efforts to lecture on chemistry, led to his receiving a very attractive offer to go to New York City and take charge of a school there. He accepted the offer and in 1807 moved with his family to New York City. In addition to conducting a school he gave, during the winter of 1807-8, a course of popular lectures on chemistry. The lucrative contract which had brought Mr. Griscom to New York terminated in 1808 with the bankruptcy of its signers. He was then thrown upon his own resources. He secured a room in which to conduct school and began at once the construction of a brick building which was to

[1] John H. Griscom, *Memoirs of John Griscom* pp. 49-50.
[2] *Ibid.*

serve both as a schoolroom and a lecture-room. Both the school and the lecture-room were patronized by the best classes of society. Griscom labored incessantly to enlarge his store of knowledge and to keep abreast of the rapid progress which the science of chemistry was making. In order to enlarge his laboratory he secured, by subscription from his more wealthy patrons, the sum of $1,500 which he expended in London for apparatus. Griscom continued his lectures on chemistry before popular audiences until 1818. Special audiences were gotten up, from time to time, from various classes of society.

> Merchants, mechanics, apprentices, professional men, females, each, as the proposals were made to them contributed to fill his benches, and swell the tide of popularity with which his efforts to extend the benefits of scientific knowledge among the masses were hailed.[3]

In 1818 Mr. Griscom began a two-year tour of Europe. While visiting in Edinburgh he was much impressed with the success of the Lancasterian high school conducted there by a Professor Pillans. He became convinced of the practicability of the plan, and following his return to New York he opened, in conjunction with Daniel H. Barnes, an instructor in the classics, a high school, March 1, 1825,[4] which he conducted on the Lancasterian plan until 1831. The venture was highly successful. When it was at the height of its success, there were enrolled as many as 650 boys and 350 girls.[5] In spite of its success, the Society of Mechanics and Tradesmen of New York made such a liberal offer for the building in which the school was housed that the trustees decided to accept it. The school was accordingly closed late in the year of 1831.[6]

During the period of its existence Griscom's high school had attracted much attention, being patronized by some of the best families of New York. Mr. Griscom said that he had to give up a considerable amount of time to answer inquiries of correspondents concerning the plan of the school. Two months after its opening Governor DeWitt Clinton[a] visited the school and "acknowledged

[3] *Memoirs of John Griscom* p. 99.
[4] *Ibid.* p. 207.
[5] *Ibid.* p. 215.
[6] *Ibid.* p. 213.

[a] Governor Clinton was very sympathetic toward the Lancasterian method. During his term of service he urged its general adoption in the schools of New York. See *The Making of Our Middle Schools* p. 305.

that the institution surpassed his expectations."[7] After the school had closed Mr. Griscom wrote:

> To the operation of the High School, during the several years of its existence, conjoined, as it was, with lectures on Natural Philosophy, Mechanics, Chemistry, Astronomy, Geology, Mineralogy, Physiology, &c., with the aid of apparatus that had cost, from time to time nearly $4,000, delivered to the higher classes of pupils, may be in some measure ascribed that pervading and quickened attention to the important subject of popular education which now so increasingly engages the mass of the thinking members of the community.[8]

Mr. Griscom's greatest activity was that of giving popular lectures on chemistry, natural philosophy, and mineralogy. These he continued at intervals until bronchitic troubles made it impossible for him to speak in public. He was convinced "that every honest and judicious attempt that was made to turn the demonstrations of science to the establishment of sound physiological truths, would meet with a response in many a mind in every popular audience."[9] He expressed regret that more professors did not use their influence to popularize subjects of instruction. There can be no doubt that Mr. Griscom's repeated and successful efforts in this direction had an important influence in promoting the cause of popular instruction in chemistry.

Josiah Holbrook (1788-1854) was another early pioneer whose life work was consciously devoted to the cause of popular education in science. His first important effort, together with that of the Reverend Truman Coe, resulted in founding in 1824 on his farm at Derby, Connecticut, an agricultural seminary which was one of the first schools in America seeking to teach a popularized form of natural science, and to combine manual labor with education. The prospectus published in the newspapers of the day gives an account of the course of study and the plan of operation.[10] This prospectus bespeaks the needs of popular education as they were recognized by Mr. Holbrook, and which he devoted his life to fulfil.

[7] *Memoirs of John Griscom.* p. 210.

[8] *Ibid.* p. 216.

[9] *Ibid.* p. 337.

[10] This account of the Agricultural Seminary at Derby, Connecticut, was furnished by a former pupil of the seminary. Barnard's *American Journal of Education* 8:248.

Mr. Holbrook planned to furnish education in the classics as well as in the other subjects usually taught in the common schools. He proposed also to provide instruction in the applications of mathematics and the sciences to agriculture and industrial pursuits. The prospectus also gave plans for the preparation of science teachers to teach in the "common schools." It was in part as follows:[11]

> The exercises designed are the study of Latin, Greek, French, and English Language, Rhetoric, Elocution, Geography, and History;—the Mathematics as Arithmetic, Algebra, Geometry, Plane and Spherical Trigonometry, Mensuration and Fluxions; Natural Philosophy in its various branches:—Astronomy, Chemistry, Mineralogy, Botany and Zoology. No effort will be spared to render these sciences practical, and fitted to common life. With that view, particular attention will be given to Composition, Declamation with extempore debates, the use of higher branches of Mathematics in common business, Practical Surveying, the application of natural philosophy to various kinds of machinery, agricultural implements, &c.,—testing the principles of chemical science in mixing and preparing soils, forming manures, making cider, beer, spirit, and various other articles of agriculture and domestic economy; agricultural, geological, and botanical excursions into various parts of the country, examining and analyzing soils, and practical agriculture.
>
> One prominent object of the school is to qualify teachers. The most approved method of instruction will be introduced and lectures will be given on most of the Physical Sciences, attended with demonstrations and illustrations sufficiently plain and familiar to admit their being introduced into common education. Courses on Natural Philosophy, Chemistry, Mineralogy, and Botany will commence at the opening of the Seminary. . . . .

This institution was unendowed, and after laboring under many embarassments for a period of two years was discontinued. Mr. Holbrook stated, however, that this brief existence was sufficient to convince him of the practicability of the plan.[12] Mr. Holbrook's desire to popularize the study of scientific subjects led him next into the field of popular lecturing on natural science subjects. In order to provide a channel for the diffusion of scientific information, he proposed, in 1826, a plan for the formation, on an extensive scale throughout the cities of the United States, of Associations of Adults for Mutual Instruction.[13] In this plan it was stated that

[11] This account of the Agricultural Seminary at Derby Connecticut, was furnished by a former pupil of the seminary. Barnard's *American Journal of Education* 8:248.

[12] *Ibid.*

[13] Josiah Holbrook, Associations of Adults for Mutual Education. *American Journal of Education* 1:594-97.

The first object of this society is to procure for youths an economical and practical education, and to diffuse useful and practical information through the community generally. . . . . The second object is to apply the sciences and the various branches of education to the domestic and useful arts, and to all the common purposes of life.

The plan proposed that branches of the society be formed in any place where a number of people were disposed to congregate for the purpose of mutual instruction. The society should hold meetings, as often as it thought expedient, for the purpose of mutual instruction in the sciences. The several branches of natural philosophy, namely, mechanics, hydrostatics, pneumatics, chemistry, mineralogy, botany, any branch of mathematics, history, political economy, or any political, intellectual, or moral subject, were to furnish material for discussion. If it was thought expedient a regular course of instruction, by lecture or otherwise, might be given. Books and apparatus for illustrating the work in the sciences were to be secured. The society might aid in establishing and patronizing institutions for the education of youths, institutions for the application of the sciences to agriculture and the other useful arts, and institutions for the training of teachers. It was proposed that delegates from all the town societies in a given county should form a county association, that delegates from the county associations should form a state association, and finally that a general board be formed embracing the United States.[14]

A few weeks after Mr. Holbrook had outlined the above proposal he delivered at Millbury, Worcester County, Massachusetts, a course of lectures on subjects in natural science, at the close of which he succeeded in inducing thirty or forty of his hearers, farmers and mechanics of the place, to organize themselves into a society for mutual improvement, which at his request was called Millbury Lyceum No. 1, Branch of the American Lyceum.[15] The formation of this lyceum at Millbury was quickly followed by that of several others in towns of that vicinity, and these were soon combined in pursuance of Mr. Holbrook's general plan of a lyceum into the Worcester County Lyceum.

[14] *Ibid.*

[15] Henry Barnard, Josiah Holbrook. Barnard's *American Journal of Education* 8:232.

From this time forward, for a period of four years, Mr. Holbrook devoted his major efforts to the organization of a system of institutions, to bear the collective name of the American Lyceum. The climax of his labors in behalf of the American Lyceum was reached when, on May 4, 1831, at the request of the New York State Lyceum, delegates from other state lyceums assembled to organize a national lyceum. Soon after the convention had assembled a committee on arrangements, consisting of Messrs. Griscom, Holbrook, Yates, Olmstead, and Sargent, was appointed, which after a short time reported a constitution for the American Lyceum. In this constitution it was stated that the object of the lyceum was the "advancement of Education, especially in the common schools and the general diffusion of knowledge."[16] By 1832 the branches of this organization had grown to extensive proportions and included eight or ten hundred town lyceums, fifty or sixty county lyceums, and several state lyceums.[17] Where town lyceums were established in the vicinity of academies the relation between the two appears to have been most salutary. Teacher and pupils contributed to the exercises of the lyceum and were in turn auditors at the lectures given by the members of the lyceum and by professional lecturers. In addition to this, the stock of apparatus in possession of the lyceum was frequently placed at the disposal of the academy.[18] The American Lyceum continued to have regular meetings until 1839, and the subject of secondary education was always a prominent one at the meetings.[b]

Mr. Holbrook's efforts in behalf of secondary education were directed to still other channels. Recognizing the need for school apparatus, he prepared and offered for sale simple apparatus for use in connection with geometry, arithmetic, geography, natural philosophy, chemistry, and astronomy.[19]

[16] American Lyceum. Constitution and notes on first meeting. *American Annals of Education* 1:273-280.

[17] Unsigned article. The American Lyceum, *American Annals of Education* 2:36.

[18] Unsigned article. The American Lyceum, *American Journal of Education* 3:703.

[19] Unsigned article. Mr. Holbrook's Apparatus for Schools and Lyceums, *American Journal of Education* 5:67-69.

[b] The proceedings of the American Lyceum, as well as the proceedings of various state, county, and town lyceums were published in the *American Journal of Education* 1826-30 and in the *American Annals of Education* 1831-39.

Growing out of the lyceum movement there developed a demand for popular articles on science for use in the meetings. To supply this need Mr. Holbrook began publishing in 1830 *Scientific Tracts Designed for Instruction and Entertainment, Adapted to Schools, Lyceums, and Families.* The first number of the *Scientific Tracts* dealt with atmosphere, the chemical changes which take place during respiration, the chemical properties of oxygen and of "carbonic acid or fixed air."[20] In 1832, Mr. Holbrook gave the publication of *Scientific Tracts* into other hands, and himself began the publication of *The Family Lyceum,* "for the use of the family circle and the village Lyceum." His aim was to publish herein "such material from the great storehouse of nature, as shall be the most highly entertaining, and the most permanently and extensively useful." Both *Scientific Tracts* and *The Family Lyceum* are said to have enjoyed a wide circulation.

Mr. Holbrook's activities in connection with the lyceum movement led him into most of the Atlantic states and as far west as the Mississippi River. His influence both directly and indirectly, through the American Lyceum, places him among the most prominent of any of our early pioneers in the cause of secondary education.

The efforts of Chester Dewey[21] (1784-1867) in behalf of secondary education, which we now turn to consider, were less extensive than those of John Griscom and Josiah Holbrook for the reason that only a relatively small portion of his life work was devoted to the field of secondary education. Mr. Dewey was principal of the Litchfield, Massachusetts, Gymnasium from 1827 to 1836, but except for this service his life was devoted to college and university work. While principal of the Litchfield Gymnasium he was appointed, by the American Lyceum, chairman of a committee to consider the advisability of introducing science subjects into the common school. While serving in this capacity

[20] Editorial Review of Scientific Tracts No. 1. *American Journal of Education* 5:247-54. Numbers I-XII bound as one volume were advertized in 1833. *American Annals of Education* 3:335.

[21] Martin B. Anderson. Sketch of the Life of Professor Chester Dewey, D.D., LL.D., Late Professor of Chemistry and Natural History in the University of Rochester and for many years a correspondent of the Smithsonian Institute. *Annual Report of the Board of Regents of Smithsonian Institute for 1870* pp. 231-40.

he prepared and read before the American Lyceum in 1833, a paper on *Natural History in the Common Schools.*[22] The prominence of the speaker secured for this paper wide publicity.

Mr. Dewey's plea was that instruction in natural history, which he defined as "the description of all the natural products to which man has access," be made a part of the work of the common schools. In support of his plea Mr. Dewey urged that the value of the knowledge gained by the study of science was sufficient justification for making a place for science in the curriculum of the common school. In addition to the value of the knowledge itself, he urged that there were indirect values attending the study of natural history. These indirect values which he enumerated were statements of disciplinary values which he insisted attended the study of science. These values were as follows:[23]

1. The study calls into efficient action the power of discrimination. The mind is trained to minuteness of examination, and to the improvement of its power of seeing and making distinctions. Thence the mind proceeds to generalizations.

2. The relation of one part to another of an object must be observed. The process of examination is fitted to induce the habit of attending to the relation of things, and of creating the power to consider the relations of things in all cases.

3. It leads to the adoption of system, arrangement, method, classification. Consider the multitude of facts in Chemistry, isolated and independent, until they were reduced to systematic order by some of the master spirits of modern times. This system, order, and arrangement is now a part of the subject itself, and the study can not be prosecuted, without this part of the logic being practically enforced upon the mind.

4. It stores the mind with objects of thought and interest, and prepares it to increase their number.

Mr. Dewey admitted that these advantages were not the most obvious but insisted upon their importance.[c] As evidence of their importance he said he knew of several instances of young men who had, by an attention to natural science, "become arrested in their mad career to intellectual and moral ruin."[24]

[22] Natural Science in the Common Schools. *American Annals of Education* 5:248-53, 304-11.

[23] *Ibid.* pp. 252-53.

[24] *Ibid.* p. 253.

[c] The same line of argument was given by A. Gray, *The Importance of the Natural Sciences in Our System of Popular Education, Lectures Delivered before the American Institute of Instruction at Boston, 1841* pp. 91-117, and by Clement Durgin, *On Natural History as a Branch of Common Education, ibid.* pp. 207-39.

In answer to the common objection, that science was a fit subject of study for mature minds only, he admitted that "the full and scientific study of Natural History in the common schools would be absurd." He insisted, though, that parts of mineralogy and geology, chemistry, botany, and zoology were most appropriate.[25]

His insistence upon the importance of chemistry is significant. He considered it a subordinate but necessary part of natural history; for, he said,

> no description will approximate completeness, which does not include the knowledge of the elementary substances and their properties, of their combinations and actions, and of the qualities of the compounds.[26]

Concerning instruction in chemistry Mr. Dewey asserted that

> a large number of experiments of the simpler kind might be performed by means of simple and common articles.

With a little expense, he said, the teacher would be enabled to exhibit some of the gases, and some of the more striking experiments.[27]

Apparently it was insisted during Mr. Dewey's time, as it has been ever since, when a new study applied for admission into the schools, that the curriculum was already full.[d] His answer to this objection has a familiar sound also for he did not urge that any of the subjects then included be displaced, but maintained that it was necessary only to provide better methods of instruction, better books, and better apparatus in order to secure from the daily program enough time for instruction in the sciences.[28]

Mr. Dewey's paper was constructive and conservative. He urged instruction in natural history in the common schools because this study was unmistakably practicable, because it was easy to understand, and because the method of study supposedly provided valuable mental discipline. Because of these values he urged that, as better methods of instruction made possible extension of the curricula, the subjects of natural history were well

[25] Natural Science in the Common Schools. *American Annals of Education* 5:251.

[26] *Ibid.* p. 248.

[27] *Ibid.* p. 253.

[28] *Ibid.* pp. 306-8.

[d] In 1836 it was "resolved" before the Vermont Literary Society, "that in the judgment of this convention, opinions favoring the introduction of a more popular course of study as a substitute for the ancient classics, have a tendency injurious to the cause of sound education." *American Annals of Education* 6:424.

worth a place of greater prominence than that which they, up to that time, had occupied.

The wide publicity given to this paper by the American Lyceum and *The American Annals of Education* gave to Mr. Dewey's efforts in behalf of secondary education an importance which must be recognized.

The influence of Stephen Van Rensselaer (1764-1839) and Amos Eaton (1777-1842) were synthesized in their efforts in behalf of the Rensselaer School at Troy, New York, which was established and endowed by Mr. Van Rensselaer in 1824, and of which Mr. Eaton was made senior professor. The work of these men and the institution of which they were in charge is deserving of somewhat extended consideration. The chief aim at the Rensselaer School was to furnish training in the application of science, and more especially to train youths for the service of science-teaching. In order to extend the influence of his school outside the bounds of its immediate vicinity, Mr. Van Rensselaer planned to train teachers who were to serve as itinerant lecturers for school communities, to lecture on the applications of the sciences to agriculture and manufacturing.

A written statement of the purpose of the school appears first in a letter from Mr. Van Rensselaer, dated November 5, 1824, and addressed to the Reverend Samuel Blatchford, in which Mr. Blatchford was asked to serve as president of the Board of Trustees. He wrote:

> I have established a school at the north end of Troy in Rensselaer County (New York) for the purpose of instructing persons, who may choose to apply themselves, in the application of science to the common purposes of life. My principal object is to qualify teachers for instructing the sons and daughters of farmers and mechanics, by lectures or otherwise, in the application of experimental chemistry, philosophy and natural history, to agriculture, domestic economy, the arts and manufactures.[29]

On December 29, 1824, after the receipt of Mr. Van Rensselaer's letter, the Reverend Dr. Blatchford called together the Board of Trustees of the Rensselaer School for their first meeting. The organization of the course of study and the methods of instruction may be learned from the minutes of the first meeting[30] at which it was

[29] *History of the Rensselaer Polytechnic Institute, 1824-1914* p. 9.
[30] *Ibid.* pp. 31-32.

Resolved, That persons attending the course of instruction at the Rensselaer School be distributed into three classes, viz.: a Day Class, an Afternoon Class, and an Evening Class. .... The exercises of the Day Class, for six hours in each day, except Sunday, shall consist of experiments in chemistry performed by the students themselves, and in giving explanations, or the rationale of the experiments; . . . . The Afternoon Class shall consist of those who may have previously attended one or more courses of lectures on chemistry at some public institution. They will hear no afternoon lectures; but their exercises will consist of a course of experiments in chemistry performed by themselves, as above, with the rationale, conducted under the superintendence of the senior professor. . . . . The Evening Class will attend lectures, on three evenings of each week, for ten weeks. This course of lectures will embrace chemistry, experimental philosophy, and the outlines of mineralogy, botany, and zoology. . . . .

The founder had stated in his first letter concerning the Rensselaer School that the purpose was to give instruction in the *application of science to the common purposes of life*. The curriculum agreed upon by the trustees in 1825 made provision for carrying out this original aim. It was ruled that

the course of exercises for the Spring Term shall be, as nearly as circumstances will admit as follows: Each student shall, during the first six weeks, give ten lectures on experimental philosophy; ten lectures on chemical powers and on substances not metallic; and ten lectures on metalloids, metals, soils, and mineral waters. For the remainder of the term each student shall be exercised in the application of the sciences before enumerated to the analysis of particular selected specimens of soils, manures, animal and vegetable substances, ores, and mineral waters; and shall devote four hours each day unless excused by one of the faculty, to the examination of operations of the agriculturists on the school farm, together with the progress of cultivated grains, grasses, fruit trees, and other plants, to practical land surveying and general mensuration, to calculations upon the application of water power and steam which is made to the various machines in the vicinity of the school and to an examination of the laws of hydrostatics and hydrodynamics which are exemplified by the locks, canals, aqueducts, and natural waterfalls surrounding the institution.[31]

The essential point of view in the method of communicating instruction was, "to instruct by putting the pupil in the place of teachers." It was argued that teachers improve themselves more by teaching than they do their students, and that advantage should be taken of this fact in imparting instruction. Each student was compelled to rely upon his own resources and prepare lectures

[31] *Ibid.* p. 41.

for delivery before his classmates and instructor. This method of instruction seemed especially useful for preparing itinerating teachers for the work they were to do.[32]

An interesting and natural inquiry in connection with the establishment of the Rensselaer School is to what extent its curriculum and methods were affected by European influence. The trustees of Rensselaer School were unwilling to admit that foreign influence affected the method of instruction or the general plan of the school. They insisted that it was neither Fellenbergian[e] nor Lancasterian[f] but purely Rensselaerian.[33]

The high standard of scholarship maintained kept the numbers small for many years and prevented the school from being self-supporting. Up to 1832 the enrollment never exceeded 25, and at one time 12 of the 25 enrolled were college graduates.[34] In the notices for the ninth annual course, 1832-33, it was announced that the patron had advanced over twenty-two thousand dollars in support of the school for the first eight years.[35]

In 1826 a "preparation branch" was provided to accomodate those who were unqualified for entrance to the school proper.[36] In 1828 "at the urgent solicitation of several judicious friends, a lady, well qualified for the duty, took charge of two experimental courses in chemistry and natural philosophy for ladies."[37]

The patron was persistent in his desire to extend the influence of his plan of instruction. He clung with great tenacity to his original object, to prepare teachers for instructing the sons and daughters of farmers and mechanics in the applications of science to "the common purposes of life." In order to extend the usefulness of the institution the faculty was authorized May 24, 1827, to establish district branches in any part of the state when application was made and assurance given by responsible persons that

[32] Extract from a pamphlet containing the constitution and laws of Rensselaer School. *American Journal of Education* 2:421-22.

[33] *Ibid.*

[34] *History of Rensselaer Polytechnic Institute* p. 69.

[35] *Ibid.*

[36] *Ibid.* p. 54.

[37] *Ibid.* p. 63.

[e] After Philipp Emmanuel von Fellenberg, whose school was established at Howffyl, Switzerland, 1808.

[f] After Joseph Lancaster. It is evident that the Rensselaerean method was greatly opposed to the Lancasterian for since each pupil was required to lecture before his instructor, the number of pupils which one instructor would be able to care for was necessarily small.

suitable rooms and sufficient apparatus would be supplied. Arrangements were made whereby students educated in these district branches might receive the same credit for their work as those who were educated at Troy.[38]

During the same year (1827) the school issued a pamphlet containing directions for introducing experimental science into academies and common schools.[39]

In the following year (1828) the patron issued an invitation to each county to furnish one student, selected by the "first judge" of the county, for gratuitous instruction. This student, in return for his instruction, was expected to return to the county from which he had been sent and engage in the work of giving instruction in the sciences in the common schools. This invitation was announced in the *Zion's Herald* of June 11, 1828 in the following words:

> *The Rensselaer School.* The founder of this school, Hon. Stephen Van Rensselaer, has given notice that any gentleman, of good moral character above the age of eighteen, who shall obtain a certificate from the first judge of any county, (who is to issue one only) in that county, that his education is sufficient to teach any incorporated academy in the county, and give assurance that if he is admitted to a course of experimental instruction at the expense of Hon. Stephen Van Rensselaer, he will return to that county and exert himself to the best of his abilities to introduce and extend the experimental plan of education, with its application to agriculture, and the arts, for the benefit of the farmers and mechanics of that county, provided he can receive a reasonable compensation for his services—shall be furnished with instruction at the Rensselaer School in Troy, during the ensuing fall term of fifteen weeks, to commence on the third Wednesday in July. He shall also be furnished with the Chymical tests, reagents, and other substances necessary to be consumed by him in his experiments, with fuel, lights, use of chymical and philosophical apparatus, library, reading rooms, cabinet, the services of the school waiter, and other advantages usually furnished to the students of said school, free of all charge.[40]

This invitation is said to have been accepted by nearly all the counties of New York state.

The extent of the influence exerted by the Rensselaer School may be inferred from a letter to the editor of the *American Annals of Education* signed by "One of the Teachers of Rensselaer School." The letter was written in reply to an article by

[38] *History of Rensselaer.* Polytechnic Institute, p. 60-61.
[39] *Ibid.* p. 61. This pamphlet was not available to the writer.
[40] Diffusion of Practical Education. *American Journal of Education* 3:573.

T. H. Gallaudet,[g] entitled "Remarks on Seminaries for Teachers" which had been published in an earlier number of the above periodical. The letter is deserving of complete reproduction here.[41]

I was astonished to learn from Mr. Gallaudet's remarks on *Seminaries for Teachers*, that neither he nor the Editor knew that a Seminary for Teachers existed in this country. It seems to be known to the Editor, that such an institution exists in one of the Cantons of Switzerland, and he speaks highly of the liberality of 150,000 inhabitants, who contribute $2,000 annually for its support. But neither editor nor correspondent ever heard of an institution of the kind, incorporated by the Legislature, in the city of Troy, New York, which has been supported almost seven years by a single individual, the Hon. Stephen Van Rensselaer, at the average annual expense of more than $3,000. There is, indeed, a consoling note to page 48, in which the Editor says, "we believe this experiment has been tried to a limited extent," &c.; and we are desirous to learn "the results," &c. In answer, I state that the results have far exceeded the most sanguine expectations of its founder, or of his immediate agents, or of the trustees. Five classes have graduated at this school, and many of the members of each class are now engaged in teaching upon the experimental and demonstrative plan; and in preparing other teachers for the same duties. Such schools are now in successful progress in Canada, Detroit, in various parts of the State of New York, Pennsylvania, Maryland, Virginia, Ohio, Kentucky, South Carolina, and Georgia. Teachers educated here, are at this moment itinerating for the diffusion of the practical method of instruction in nearly every State of the Union—not by useless declamation in favor of this method of instruction; but by giving from thirty to forty experimental exercises in Chemistry and experimental philosophy, and teaching the analysis of minerals, plants, animals, &c., wherever they are employed. Many of the practical improvements described in the journals of the few last years were the *unacknowledged* improvements exhibited by our itinerating and permanent teachers.

It may be asked, why has not the true character of the Rensselaer method of instruction been better appreciated in the eastern parts of New England? I answer, the patron totally forbids any publication, other than a plain statement of the simple facts necessary to be known, and of the terms of admission. Such statements have been published; but in these days of extravagant boastings, simple truths are received with much allowance for presumed overrating.

[41] Correspondence to the editor. *American Annals of Education* 1:231.

[g] Thomas Hopkins Gallaudet (1787-1851). Founded the first American asylum for deaf-mutes and introduced the sign alphabet into America. During 1832-33 he was professor of education and philosophy in New York University. This was the first professorship of education held in the United States. Monroe's *Cyclopedia of Education.*

Mr. Gallaudet's remark applies to this subject with considerable force where he says—"Information must be gradually diffused"—the whole mass of the community cannot at once be electrified, as it were, into one deep and universal excitement. In addition to this, one assistant is required to every five persons who are to be thus prepared for experimental teachers of common schools; consequently the progress of preparing teachers is expensive and slow. Showing all the necessary manipulations, teaching the names and characters of the subjects of Natural History, the method which long experience has taught for teaching by extemporaneous lectures, essays, &c., given by the learner, requires the perpetual presence and constant labour of a teacher, with so small a number that all can stand around the same cistern, furnace, set of specimens, &c.

Yours Respectfully,
ONE OF THE TEACHERS OF RENSSELAER SCHOOL

It is difficult to separate the influence of Amos Eaton from that of Stephen Van Rensselaer. From 1824 to 1842 Eaton was senior professor and chief spokesman for the Rensselaer School. The publications of the Rensselaer School were liberal in allowing to Mr. Van Rensselaer credit for formulating his plan of instruction. It is certain that the relations between these two men were always most harmonious. Eaton was educated to be a lawyer and followed this profession from 1803 to 1815. His interest in natural science, however, was always uppermost, and in 1815 he gave up his legal practice and went to Yale to prepare himself for more useful work in this field. While there he received much encouragement from Professor Benjamin Silliman, who was at that time probably the most prominent American scientist.[h] From there he went to the faculty of Williams College, where he formed an intimate and lasting friendship with Professor Chester Dewey. He labored to increase the fund of scientific knowledge by making geological and botanical surveys, and endeavored to increase the popularity of science by giving popular lectures illustrated by experiments.[42] Before the Rensselaer County (New York) School Association of which he was president, and through which he labored to interest teachers of the common schools and academies in teaching science, Mr. Eaton delivered an address in which he attempted to answer the question: "To what extent can instruction in natural science be introduced into our common schools?"[43] Mr. Eaton maintained in common with

[42] *History of William's College* pp. 361-71.
[43] *American Annals of Education* 1:372.
[h] G. P. Fisher, *Life of Benjamin J. Silliman.*

Chester Dewey[1] that the sciences could be taught without neglecting those subjects usually included in the common-school curriculum if better instructors for these schools could be prepared. He advised especially the plan of instruction for training teachers that was being used at the Rensselaer School. He advised further, that until instructors generally should become qualified, circuit or itinerating teachers should be employed to attend to these branches of instruction in the schools of a particular district, giving one lecture every week, and directing and advising the instructor in pursuing the course.[44] The industry and enthusiasm displayed by Professor Eaton made him an invaluable man to aid in promoting the plan for extending the teaching of science.

The work of John Griscom, Josiah Holbrook, and Chester Dewey as individuals, and of Stephen Van Rensselaer and Amos Eaton as the guiding spirits of the Rensselaer School, represents the most influential of the agencies working in behalf of science instruction in secondary schools that the available literature has revealed. Josiah Holbrook was the leading instigator and organizer of the American Lyceum, and without his efforts this organization would probably never have come into existence. It is certain, however, that Griscom, Dewey, and Eaton were by no means the only individuals to champion from the popular platform the cause of secondary instruction in science; but their efforts were probably more insistent and better organized than those of others, and were given greater prominence in the available literature. The Rensselaer School was probably one of the most influential of a type of which it was by no means the sole representative. It is impossible to measure the influence of the foregoing personages and organizations. Only the object toward which they were working can be definitely given. Among the many motives stimulating these efforts was the desire to improve education. Their efforts were indorsed and promoted by the recognized leaders of education of the period in which they lived. It is highly probable that there were influences other than those noted above that were working in support of instruc-

[44] *American Annals of Education* 1:372.

[1] Ante p. 33.

tion in the sciences[1] in secondary schools, and certainly one which is deserving of mention is the fact that chemistry and other natural sciences were required subjects of study in certain of the secondary schools of Germany and France. Before concluding this study it is desirable to discover what place was provided in the curricula of our earliest high schools for the study of natural science.

[1] The influence of the Pestalozzian movement was exerted chiefly in support of the elementary schools. This movement, however, was not without influence on the secondary-school subjects, for in the first American Pestalozzian school chemistry was taught "by the latest and most approved methods." William McClure, An Epitome of an Improved Pestalozzian System of Education, *American Journal of Science* 10: 145-51. Again it was said that "among the foremost subjects for visible illustration must be reckoned the branches of Natural history and the physical sciences in their most extended sense." Chemistry was mentioned as especially valuable. W. R. Johnson, On the Utility of Visible Illustration. *American Annals of Education* 3:97-112.

CHAPTER IV

CONCLUSION—CHEMISTRY IN THE EARLY HIGH SCHOOLS

It is impossible to furnish satisfactory data as to the number of high schools existing in the United States prior to 1860. Both before and after this date, school statistics were frequently not gathered, and such as were compiled were often incomplete, often unreliable. It need occasion no surprise therefore that such statements as are available concerning the number of high schools in the United States during this early period are conflicting. W. T. Harris asserts that the number of high schools in the United States in 1860 was 40.[1] Yet Brown states that Massachusetts alone had as many as 64 high schools in 1852 and Ohio as many as 97 in 1856.[2] Statistics gathered by the United States Commissioner of Education in 1903-4 indicate that previous to 1860 there were in the United States 321 high schools.[3] It is possible that the wide variation in the data given by different authorities is due to the fact that during the period from 1830 to 1860 many secondary schools were in a state of transition, and are classified by some authorities as public high schools and by other authorities as academies.

Massachusetts took the lead in establishing free public high schools. According to the above report of the Commissioner of Education, this state had 37 public high schools in 1850.[4] In Ohio, following the passage of the "Akron Law" in 1847,[5] high schools were established in many cities, with the result that by 1860 these two states were well in the lead of all others in number of high schools. According to Brown the first ten high schools were in New England[6] and the eleventh was in Philadelphia.[7]

[1] W. T. Harris, Recent Growth of Public High Schools in the United States as Affecting the Attendance of Colleges, *Addresses and Proceedings of the National Educational Association, Fortieth Annual Meeting, Detroit, Michigan, 1901* p. 175.

[2] *The Making of Our Middle Schools* p. 313. See also E. S. Miller, High Schools in Ohio Prior to 1850, *School Review* 28:455-69.

[3] *Report of the United States Commissioner of Education for the Year Ending 1904* pp. 1782-1889.

[4] *Ibid.*

[5] *The Making of Our Middle Schools* p. 353.

[6] Edmonds, *History of Franklin High School of Philadelphia* p. 29. An extended quotation from a letter of E. E. Brown's is given in footnote.

[7] *Ibid.*

The following table presents the names of the eleven earliest New England high schools cited by Brown and Inglis, together with the dates of their establishment.

TABLE IV

EARLIEST NEW ENGLAND HIGH SCHOOLS[a]

	FOUNDED
1. The English Classical School, now the English High School, Boston	1821
2. The High School for Girls, Boston. Discontinued 1828. Re-established 1852	1826
3. New Bedford, Massachusetts	1827
4. Haverhill, Massachusetts	1827
5. Salem, Massachusetts[8]	1827
6. Burlington, Vermont	1829
7. Lowell, Massachusetts	1831
8. Medford, Massachusetts	1835
9. Augusta, Maine	1835
10. Brunswick, Maine	1835
11. Pittston, Maine	1837

Using the data given in the Federal Commissioner's report of 1903-4, Inglis has compiled the following table (Table V) which shows, in a general way at least, the rate of development by decades of high schools in the United States.[9]

In view of the fact that the academy was the forerunner of the public high school, no other educational institution played a larger part in determining the character of the latter. In a considerable number of cases academies were converted into public high schools with free tuition. In other cases academies with endowments reduced the tuition charge to a small fee, and thus were able to compete with the free high schools. Chemistry, occupying, as it did, a rather prominent place in the academy, was a part of the large heritage which the high school gained from the academy, and its introduction into high schools was contemporaneous with their development. In this study of the teaching of chemistry in the early high schools, our attention is necessarily directed to those states and cities which first provided public high schools, namely, Massachusetts and Ohio, and the cities Philadelphia, Chicago, and St. Louis.

[8] Inglis, *Rise of the High School in Massachusetts* p. 44.

[9] *Ibid.* p. 155.

[a] All data in this table except as otherwise indicated are taken from Brown. (See footnote 6.)

TABLE V

ESTABLISHMENT OF HIGH SCHOOLS IN THE UNITED STATES[b]

	BEFORE 1820	1820-30	1831-40	1841-50	1851-60	TOTAL
Massachusetts	3	2	6	26	41	78
Vermont	1	1	2	2	3	9
New Hampshire...	1	1	0	3	2	7
Maine	2	0	3	5	4	14
Connecticut	1	0	3	2	2	8
Rhode Island.....	0	0	0	3	2	5
New York.....	1	4	5	9	22	41
New Jersey.....	0	0	1	0	3	4
Pennsylvania	0	0	1	4	12	17
Ohio	0	0	0	15	33	48
Illinois	1	0	0	0	9	10
Indiana	0	0	0	0	9	9
Michigan	0	0	0	7	12	19
Wisconsin	0	0	0	1	6	7
All others.....	3	1	5	13	23	45
	13	9	26	90	183	321

The early Massachusetts high schools quite generally provided instruction in chemistry. The findings of Inglis in his study of *The Rise of the High School in Massachusetts* support the thesis stated on page 1 of this study, namely, that during the first half of the nineteenth century instruction in elementary science was prominent in many secondary schools. The second high school to be established in the United States, the Boston High School for Girls, was the first to provide definitely for chemistry.[10] This school was founded 1826. It was provided that the course of study "should include as much chemistry as would be useful in domestic economy." Chemistry was placed in the third year and made a required subject of the first course of study offered.

From the reports of Massachusetts high schools issued previous to 1861, Inglis has computed the per cent of the total high school students who were enrolled in the various subjects included in the curricula. The following table summarizes the total

[10] Boston High School for Girls. Extracts from the Records of the Boston School Committee. *American Journal of Education* 1:99.

[b] Some of the schools included in this report apparently reported as the date of their establishment the date at which the academy, which later became the public high school, was established. There is no record of any free high school in existence previous to 1820, yet this table includes thirteen.

number of students enrolled in four Massachusetts high schools, together with the per cent of enrollment taking chemistry.[11]

TABLE VI

PER CENT OF STUDENTS ENROLLED IN CHEMISTRY IN FOUR MASSACHUSETTS HIGH SCHOOLS FOR YEARS INDICATED

HIGH SCHOOL	ENROLLMENT	PER CENT IN CHEMISTRY	YEAR
Northampton	274	4.4	1837
Haverhill	72	2.0	1842
Lowell	...	22.0	1850
Springfield	166	16.9	1856

In addition to the towns included in Table VI, in three towns considered collectively the number of students enrolled in chemistry in 1860 was 41.2 per cent of the number enrolled in algebra,[12] and of five towns considered collectively the number of students enrolled in chemistry in 1860 was 50.7 per cent of the number enrolled in algebra.[13]

In 1857 Massachusetts passed a law which remained in force until 1898 when it was repealed. This law provided that

> Every town may and every town containing 500 families or households .... shall maintain a school kept by a master .... who .... shall give instruction in general history, book-keeping, surveying, geometry, natural philosophy, chemistry, botany and ....[14]

In 1860-61 there were in Massachusetts 55 towns of 500 families or over.[15] Inglis found that of these 55 towns 52 included chemistry in their course of study.[16] Not only did the high schools in Massachusetts generally teach chemistry, but instruction in chemistry even outstripped the development of high schools. It is significant that in 1840, when 301 towns reported, there were 57 which claimed to offer instruction in chemistry,[17] yet the best information available shows that there were but 11 public high

[11] *Rise of the High School in Massachusetts,* Tables XXVII p. 88, XXXI p. 91, XXXII p. 93.

[12] *Ibid.* Table XXIX p. 89.

[13] *Ibid.* Table XXX p. 90.

[14] *Twenty-fourth Annual Report of the Massachusetts Board of Education* together with the *Twenty-fourth Annual Report of the Secretary of the Board 1861* p. 91.

[15] *Rise of the High School in Massachusetts* p. 84.

[16] *Ibid.*

[17] *Ibid.* Table XVIII p. 75 and Table XXXV p. 155.

schools in Massachusetts in 1840. It is interesting to note that other natural-science subjects were taught at this time in many towns which had no high school. Of the same 301 towns reporting in 1840, 170 taught natural philosophy, 58 taught astronomy, 9 taught botany, and 2 taught anatomy and physiology.[18] No subject of those commonly taught in secondary schools, except United States history, was more widely taught than natural philosophy, and there were more than twice as many towns offering instruction in chemistry as in geometry. It is evident therefore that the natural-science subjects occupied a very prominent place in the public schools of Massachusetts during the first half of the nineteenth century.

TABLE VII

NUMBER OF STUDENTS ENROLLED IN THE HIGH SCHOOLS OF OHIO, NUMBER OF STUDENTS ENROLLED IN CHEMISTRY, AND THE PER CENT WHICH THE ENROLLMENT IN CHEMISTRY IS OF THE TOTAL HIGH-SCHOOL ENROLLMENT

YEAR	HIGH SCHOOL ENROLLMENT	CHEMISTRY ENROLLMENT	PER CENT
1854 (76)[19]	2414	642	26.6
1855 (87)	7522	906	12.0
1856 (82)	8554	514	6.0
1857 (130)	8372	729	8.7
1858 (28)	10729	786	7.2
1859 (27)	10518	941	8.9
1860 (34)	13183	1141	8.6
1861 (51)	12902	873	6.8
1862 (11)	7333	890	12.0
1863 (54)	8341	777	9.3
1864 (91)	11881	685	5.7
1865 (17)	9114	565	6.2
1866 (17)	9582	517	5.3
1867 (15)	11355	666	5.8
1868 (26)	11958	679	5.7
1869 (67)	12146	831	6.8
1870 (80)	18828	664	3.5
1871 (27)	22690	823	3.6
1872 (36)	21855	853	3.9

A brief consideration of the early high schools in Ohio will show that chemistry was quite generally included in the secondary

[18] *Rise of the High School in Massachusetts* p. 84.

[19] Number in parenthesis refers to page in report of Commissioner for year indicated, from which data are taken.

course of study in this state also. The first published *Annual Report of the Ohio State Commissioner of Common Schools* appeared in 1854. In this report and in the subsequent annual reports are given definite statements of the number of students in the state enrolled in high schools, and the number of students enrolled in the various high-school subjects. Table VII presents this data for the years 1854-72 inclusive.

Table VIII is inserted for the sake of showing the importance of chemistry in Ohio high schools compared with other high school subjects in the year 1856.[20]

TABLE VIII

NUMBER OF PUPILS STUDYING VARIOUS SUBJECTS IN OHIO IN 1855-56

SUBJECT	PUPILS	SUBJECT	PUPILS
Algebra	5790	Zoology	165
Geometry	934	Latin	675
Natural Philosophy	1167	Greek	113
Chemistry	514	German	903
Rhetoric	404	French	180
Astronomy	655	Botany	53
Geology	297	Trigonometry	5

Chemistry was quite generally included in the high-school curricula of the larger cities in states other than Massachusetts and Ohio. In the Central High School of Philadelphia, established in 1838, and the first in that city, James C. Booth[c] was appointed instructor in chemistry in 1842.[21] The first building did not contain a laboratory. In the new building which was occupied in 1854 a laboratory for chemistry and natural philosophy was provided.[22] In the first high-school buildings erected in Chicago[23] and St. Louis,[24] provisions were made for chemical laboratories. Further evidence of the importance of chemistry as a subject in

[20] *Third Annual Report of the State Commissioner of Common Schools (Ohio) for the Year Ending August 31, 1856* p. 6.

[21] *History of Central High School of Philadelphia,* p. 57.

[22] *Ibid.* p. 142. See also article by John S. Hart, Description of a Public High School in Philadelphia, Barnard's *American Journal of Education* 1:93.

[23] W. H. Wells, Public High School in Chicago, Barnard's *American Journal of Education* 3:531.

[24] J. H. Tice, First Annual Report of the St. Louis Schools, Barnard's *American Journal of Education* 1:353.

[c] James C. Booth, 1810-88, was graduated from the University of Pennsylvania in 1829. He afterwards studied at the Rensselaer School and later under Wöhler and Magnus in Germany. He had an eminent reputation as a chemist. He served in the Central High School of Philadelphia from 1842 to 1845, after which he was appointed refiner in the United States Mint at Philadelphia, which position he held until his death. Edmonds' *History of Central High School of Philadelphia* p. 57.

the early high schools may be gleaned from a study of the American public schools conducted by Henry Barnard in 1867. According to Barnard, of 30 of the larger cities in the United States, 26 taught chemistry in 1867. The extent to which chemistry, compared with other subjects, was taught in the 30 cities listed by Barnard is shown in the following table.

TABLE IX

NUMBER OF HIGH SCHOOLS TEACHING CERTAIN SUBJECTS[25]

SUBJECT	NUMBER OF SCHOOLS TEACHING	SUBJECT	NUMBER OF SCHOOLS TEACHING
Algebra	30	Physical Geography	25
Geometry	30	Botany	24
Natural Philosophy	30	Arithmetic	23
Rhetoric	28	Trigonometry	22
Physiology	28	Geology	21
Latin	27	English Literature	21
History	26	Greek	18
Chemistry	26	Bookkeeping	18
Astronomy	25	German	15

The cities in Barnard's lists which taught chemistry in 1867 were:[26]

Baltimore	Indianapolis	Providence
Boston	Lewiston, Maine	Rochester
Cambridge	Louisville	Sandusky
Chicago	Manchester	San Francisco
Cincinnati	New York	Springfield, Illinois
Cleveland	New Haven	St. Louis
Dubuque	Niles, Michigan	Terre Haute
Fond du Lac	Philadelphia	Worcester
Hartford	Portland	

The thesis which this paper has attempted to prove is that chemistry was an important secondary-school subject prior to 1850. The argument presented may be summarized as follows:

A. The way for the introduction of chemistry into the secondary schools was prepared early in the nineteenth century by at least three important developments:

[25] Henry Barnard, Rules and Regulations of Public Schools, Barnard's *American Journal of Education* 19:463.

[26] *Ibid.*

1. The first three decades of the nineteenth century witnessed a rapid growth of interest in chemical and other scientific study.[27]

2. As early as 1800 chemistry was taught in at least 4 American universities (or colleges) and by the year 1839 there were at least 37 colleges and universities in which it was taught.[28]

3. Seven important scientific societies were established in America between 1800 and 1817.[29]

B. The following lines of evidence show that chemistry had gained a place in the secondary schools prior to 1850.

1. Chemistry was taught in at least 1 academy (Onondaga, New York) as early as 1813; at least 16 included chemistry in their curricula as early as 1826; and at least 34 as early as 1840.[30]

2. As early as 1836 there were at least 8 elementary texts and 19 more complete treatments on chemistry offered for sale in the United States.[31]

3. Prior to 1850, for the purpose of extending the teaching of chemistry and other natural sciences in secondary schools, certain prominent individuals, chief of whom were John Griscom,[32] Josiah Holbrook,[33] Chester Dewey,[34] and Amos Eaton,[35] gave popular lectures on scientific subjects and fostered the formation of scientific societies.

4. The specific aim of the American Lyceum, established in 1830, was the extension of the study of natural science in common schools.[36]

5. The principal object of the Rensselaer School, established in 1824, was

> to qualify teachers for instructing the sons and daughters of farmers and mechanics, by lecture or otherwise, in the application of experimental chemistry, philosophy, and natural history, to agriculture, domestic economy, the arts and manufactures.[37]

[27] Cf. p. 2 ff.

[28] Cf. pp. 5-6.

[29] Unsigned article. Survey of the Progress and Actual State of Natural Sciences in the United States from the Beginning of the Century to the Present Time. *American Monthly Magazine* 2:82.

[30] Cf. pp. 16-17.

[31] Cf. pp. 21-23.

[32] Cf. pp. 24-27.

[33] Cf. pp. 27-31.

[34] Cf. pp. 31-34.

[35] Cf. pp. 39-40.

[36] Cf. pp. 28-29.

[37] *History of the Rensselaer Polytechnic Institute, 1824–1914* p. 9.

6. In Massachusetts, which was the pioneer state in establishing high schools, chemistry very early secured a place in the curriculum. The first high school was established in 1821[38] and chemistry was first offered as a high-school subject in 1826.[39] In 1857 Massachusetts passed a law which required every town of 500 families to establish a school in which among other subjects chemistry should be taught.[40]

7. In Ohio in 1854, 26.6 per cent of all high-school students were enrolled in classes in chemistry.[41]

8. In 1867 many of the high schools of the larger cities in all parts of the United States provided instruction in chemistry.[42]

[38] *History of Franklin High School of Philadelphia* p. 29.

[39] Boston High School for Girls. Extracts from the Records of the Boston School Committee. *American Journal of Education* 1:99.

[40] *Twenty-fourth Annual Report of the Massachusetts Board of Education* together with the *Twenty-fourth Annual Report of the Secretary of the Board 1861* p. 91.

[41] Cf. p. 45.

[42] Rules and Regulations of Public Schools. Barnard's *American Journal of Education* 19:463.

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